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Forest Health Protection

Pacific Southwest Region
Northeastern California Shared Service Area

Date: March 2, 2018
File Code: 3420

To: District Ranger, Hat Creek Ranger District, Lassen National Forest

Subject: Health of Baker Cypress in Whittington Project Area (FHP Report NE18-05)

On August 21, 2017, Bill Woodruff, Forest Health Protection Plant Pathologist, with District Sale Prep Forester Naomi Brown examined groves of Baker cypress (*Hesperocyparis bakeri*) in the Whittington Project area. The purpose was to determine if Heterobasidion root disease is the cause of high Baker cypress mortality and the overall decline occurring in this unique species which grows only in California and Oregon on less than 7500 ac. Almost no cypress regeneration was observed. Nearby white fir trees have symptoms of Heterobasidion root disease but no evidence of this disease was found on the cypress. Many of the Baker cypress trees are heavily parasitized by mistletoe (*Phoradendron densum*) (Figures 1 and 2). Large numbers of mistletoe plants growing on a cypress tree can seriously weaken it by stealing its water. Moisture stress in the Baker cypress caused by drought, mistletoe and competing trees may be why many cypress trees are dying. Baker cypress doesn't grow well in the understory because is not shade tolerant.

Figure 1. Baker cypress in Whittington Project area infested with mistletoe (*Phoradendron densum*) (left) Live cypress; (center) Dead cypress heavily infested; (right) Dead cypress very heavily infested. Note that all these cypress trees are in a crowded forest surrounded by taller conifers

Figure 2. Parasitic mistletoe plant on cypress

In the Whittington Project area, a large percentage of the Baker cypress trees have died (Figures 1, 3 and 4). The pine and white fir overstory trees are out-competing the Baker cypress trees for sunlight and water.

Baker cypress is a fire dependent species that grows poorly in shade. Healthy new stands begin following stand-replacing fire which removes overhead shade and exposes bare mineral soil to grow trees from the seeds released from cypress cones opened by the fire’s heat. Decades of growing without fire results in the accumulation of huge numbers of closed seed-filled cypress cones in standing and downed cypress trees (Figure 5). Without bare mineral soil the fragile Baker cypress seedlings are easily killed by damping off fungi in the moist shade of ground vegetation and litter. Without removing shade from overstory trees, cypress seedlings won’t grow.

The decline of the Baker cypress seen in the Whittington Project is occurring in other places Baker cypress grows. In the Mud Lake-Wheeler Peak area of Plumas County, CA Baker cypress is being replaced by overstory true fir trees. There, hundreds of cypress saplings and pole-sized trees have died with no indication of insects or disease. Shade and thick duff created an unfavorable environment for the establishment and survival of Baker cypress trees and seedlings.

Symptoms of insect activity were observed in a number of dead Baker cypress trees.

Figure 3. Baker cypress snag with top and cones on ground.

Figure 4. Dead and down understory cypress.

Figure 5. Closed Baker cypress seed cones. Note the orange mistletoe stems (center)

Woodborer frass and exit holes (Figures 6 and 7) and woodpecker feeding (Figures 8) were observed on

Figure 6. Wood borer frass under dead cypress bark.

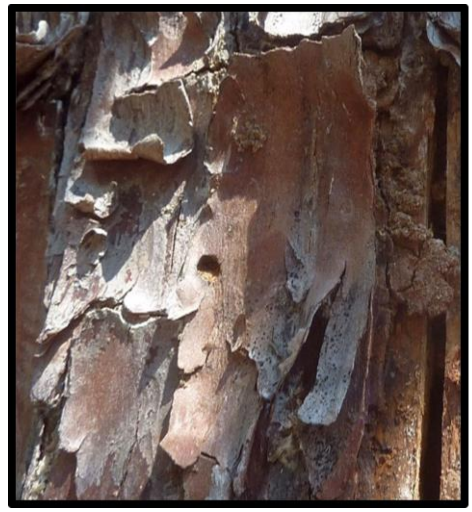

Figure 7. Wood borer exit hole

dying trees. Carpenter ant activity and boring dust (Figure 9) on one cypress tree most likely happened after the tree died.

Figure 8. Woodpecker feeding on wood borers.

No insect or disease was determined to be responsible for the dead Baker cypress found in the Whittington Project area. The most likely cause for the mortality is the inability of the cypress to grow in the shade of the pine and fir which has been gradually over-topping the smaller cypress trees. Many of the overstory white fir trees in the area are growing slower than expected, as indicated by their suppressed, rounded tops. In addition to poor site, slow growth is probably a result of the fir roots being infected with *Heterobasidion occidentale*, a root disease fungus. Even though infected white fir trees surround the Baker cypress (Figure 10) throughout the area, no evidence was found to prove that Heterobasidion root disease is in the cypress trees. A small fungal growth found under the bark of a dead cypress tree (Figure 11) tested negative for the disease. Testing of root wood from declining and dead cypress trees should be completed before root disease is ruled out as a contributing factor to the cypress mortality.

Figure 9. Carpenter ant boring dust.

Regardless of whether root disease is present in the Baker cypress, management is needed to ensure the survival of this species in the Whittington Project area. Baker cypress is thought to have once grown in a much larger area in northeastern California. Now it exists on about 7500 acres in California and Oregon; the only place it grows on earth. Most Baker cypress (7000 acres) in existence grows near Timbered Crater twelve miles north of Fall River Mills. This location is the only Baker cypress population growing as a “stand” of trees. At the other 8 locations where Baker

cypress grows, the trees are present in small groves in large conifer stands. The Whittington Project area has a number of small Baker cypress groves within its boundaries. All of the cypress groves in this report appear to be in serious decline. Over several decades, the conifer forest around each grove has increased in both density and height to the point that, except for a few healthier cypress trees (Figure 12), most of the Baker cypress trees are suppressed and dying without enough sunlight. Drought, mistletoe and possibly root disease may be contributing factors to the mortality.

Figure 11 Fungal growth from a dead cypress that tested negative for *Heterobasidion occidentale*.

Figure 10. (front) Dying Baker cypress with mistletoe (behind) Rounded-top white fir probably with *H. occidentale* infecting its roots..

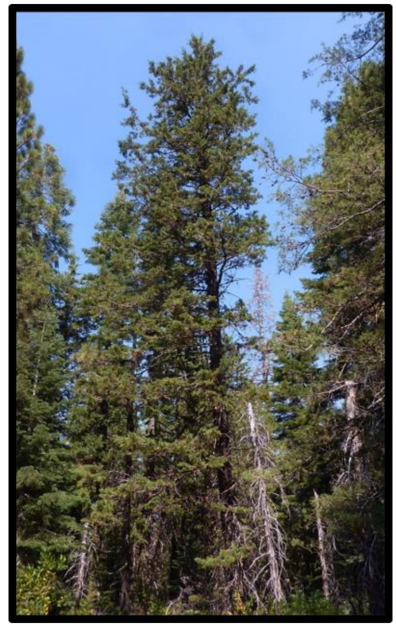

Figure 12. Apparently healthy Baker cypress infected with mistletoe (*P. densum*).

Historically, Baker cypress has successfully regenerated following stand replacing fire. This fact was recently demonstrated in the Eiler Fire that burned a nearby grove of Baker cypress where now more healthy cypress seedlings are growing than are needed to replace the grove and maybe even expand the grove boundaries; providing the site doesn't burn again before the cypress seedlings mature and produce the healthy reservoir of seed cones needed to survive the next burn. In the Whittington Project area, burning each grove after removing all competing conifers from within and around the grove is the best way maintain the grove and grow new Baker cypress trees. When relatively healthy live cypress trees (Figure 12) burn, the mistletoe in them will die, seed cones accumulated over decades will open and release large numbers of seed, the surrounding soil will be exposed, and shade from the tree will be eliminated (all which aid establishment, survival and growth of healthy Baker cypress seedlings). Lastly, the seed from dominant Baker cypress trees (ie. superior phenotypes) have a chance of producing genetically superior seedlings. Therefore, it may be wise to burn dominant overstory trees when regenerating Baker cypress groves.

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Heterobasidion root disease

Heterobasidion spp. is a fungus that infects primarily conifers on all National Forests in California; with incidence particularly high in true fir stands in northern California, in eastside pine type forests, and in southern California recreation areas. While Heterobasidion root disease is a natural part of most forest ecosystems in the West contributing to structural and species diversity, incidence and impacts in many California forests have increased in recent decades due to management practices. Heterobasidion root disease is found on all western conifer species but is of most concern on true firs, hemlocks (western and mountain) and pines (ponderosa and Jeffrey). Incense cedar, coast redwood and sequoia are sometimes infected in California. Western juniper is infected throughout its range.

Heterobasidion is an important stress-causing agent and its negative impacts on root systems result in predisposing conifers to bark beetle attack. In true firs severely affected by Heterobasidion root disease, the water absorbing and conducting parts of the root system are progressively diminished and eventually water lost to transpiration cannot be replaced at a fast enough rate. This leads to moisture stress, especially towards the top of the tree, and predisposes the tree to fir engraver attack. In pines affected by this disease, root systems are similarly impacted and the trees become more susceptible to pine bark beetles.

Heterobasidion spp. was considered a single species (*Fomes annosus*) until thirty years ago. Heterobasidion root disease in western North America is now reported to be caused by two species: *Heterobasidion occidentale* (also called "S-type" [spruce]) and *H. irregulare* (also called "P-type" [pine]). These two species of *Heterobasidion* have major differences in host specificity. *H. irregulare* (P-type) infects ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, lodgepole pine, incense cedar, western juniper, pinyon, and manzanita. *H. occidentale* (S-type) infects true fir, mountain hemlock, Douglas-fir, giant sequoia, coast redwood, western hemlock and spruce. Both Heterobasidion species can infect stumps of non-hosts as saprophytes; however the fungus very rarely spreads from a non-host to a host species, either between trees or stumps and trees.

The typical pattern of Heterobasidion root disease in pine stands is scattered dead pine trees centered around large old pine stumps. There are often old dead snags and downed trees with rotten roots near the stumps and more recent mortality and symptomatic live trees further away. Mortality usually does not start to occur around stumps until 15 or more years after they are created.

In true fir stands, Heterobasidion root disease often does not produce obvious evidence of infestation. Mortality is infrequent to rare in standing trees, but large true fir trees with extensive root and butt rot may be broken or windthrown; and have declining crowns and dead branches. Other infected true fir trees of all sizes may have green crowns with poor height growth and dead tops from successful fir engraver attacks. Sometimes the presence of *H. occidentale* is only discovered when a stand is thinned or harvested and decay and stain is observed in the stumps.

Colonization of freshly created stump or wound surfaces by germinating spores is a critical stage in the disease cycle. Conks (fruiting bodies) produce spores which disseminate throughout the year, but depend on favorable environmental conditions for successful germination and establishment. Temperature is important for successful infection of stump surfaces. Spores are inactivated after 60 minutes above 113º F (45º C). Actively growing mycelia can be killed at temperatures above 95º F (35º C). However research suggests that microbial activity at the stump surface plays a synergistic or interactive role in stump infection. Therefore both 95º F tempera-ture and microbes are thought to be needed to stop *Heterobasidion* spp. at the stump surface.

Stumps are susceptible to infection immediately after cutting. Ponderosa and Jeffrey pine (PP/JP) stumps remain susceptible to infection for 2 to 4 weeks. The decrease in susceptibility with time probably results from colonization of the stumps by other microorganisms that compete with and replace *Heterobasidion* sp. Vertical penetration of fungal hyphae into stumps depends on temperature and extent of tree injury from other sources. In PP stumps, the rate of vertical penetration averages 3 inches/month from October through May and 5 to 6 inches/month from June to October.

Preventive actions may include implementing silvicultural treatments to lessen stand susceptibility to Heterobasidion root disease such as thinning, species management, and minimizing logging damage and other injuries. However, many silvicultural treatments leave stumps behind; therefore prevention of Heterobasidion root disease usually includes treatment of freshly-cut conifer stumps with a fungicide. The probability of infection of freshly cut conifer stumps can be reduced by applying a registered borate fungicide soon after the tree is felled. Studies indicate that stump treatment with borates has at least a 90% efficacy in preventing infection under conditions that would otherwise have led to stump colonization by *Heterobasidion* spp. Borates are toxic to recently germinated spores of these fungi but they do not have an effect on existing infections. Therefore true fir stands with most of the roots chronically infected may not benefit from borate stump treatment. Borate treated PP/JP stumps 14" and larger will usually be effective in limiting Heterobasidion root disease in stands where existing host conifers have root contact with the roots of treated stumps.

When a stand is cleared, by clearcutting or wildfire salvage logging, and planted with PP/JP seedlings, Heterobasidion-caused seedling mortality can only occur when a root of a seedling grows into contact with an infected pine root. The years it takes a PP/JP seedling root to grow into contact with a root of an infected pine stump provides opportunity for soil microbial activity to colonize and begin decomposition of the stump root; thereby excluding Heterobasidion. Small roots are colonized and decomposed fastest; larger roots require many years. The smaller a PP/JP stump, the smaller its roots and the more likely the roots will be colonized by competing organisms; making them incapable of spreading *Heterobasidion* spp. The preceding discussion may explain why in four eastside pine stands surveyed on the McCloud Ranger District, Shasta-Trinity National Forest in 1988, untreated pine stumps less than 30" in diameter had less than 10% infection rates from *Heterobasidion* spp. Twenty years of informal monitoring of JP/PP planted clearcuts on private and public lands in northeastern California found minimal seedling mortality in clearcuts where stumps were not treated with borates. Usually one or two planted seedlings located next to an occasional very large infected pine stump or two in each clearcut are killed by *H.* irregulare within a decade of planting; and the disease appears to stop there; suggesting no need to treat stumps in clearcuts and fire clearings where PP/JP seedlings will be planted. When a true fir stand infested with Heterobasidion root disease is cleared and planted with pine seedlings, stump treatment is also unnecessary because *H. occidentale* typically does not kill pine seedlings.

References

USDA FS Forest Insect and Disease Leaflet 172 (Revised February 2000)

USDA FS General Technical Report PSW-116; Proceedings of the Symposium on Research and Management of Annosus Root Disease (*Heterobasidion annosum*) in Western North America April 18-21, 1989, Monterey, California.

USDA FS Handbook - R5 SUPPLEMENT 3409.11-2013-1; Forest Health Protection Handbook, Chapter 60 – Management of Specific Pests; Effective Date - 6/10/2013